A note to whomever ends up assembling this lab report: I’ve left notes in red to help with labeling references to other sections of the lab report. These should be removed before submitting the final paper.

Words in purple indicate where the references to other sections (ex: introduction for equations, etc) are in this section for easy finding and potential fixing, and should not be removed. Just make sure to color them back to black before submitting the final paper.

The graphs required (there should be 12 of them) are in separate tabs in the data reduction’s excel file. I tried placing all on one page, but the density of the data points (6,000 per graph) made the oscillation pattern unrecognizable.

The tables in the data reduction file are labeled in purpled for referencing convenience, as there are too many to put in this section, and should then be included in the appendices. Because the appendices haven’t been made yet, I’m just calling them all “Appendix X”.

# Discussion of Results

Only four trials instead of the planned eight for the first steel pendulum length were obtained and the data that was recorded was suspect. This is attributed to equipment failure, specifically the strain gauge on the pendulum shaft. Because the aluminum pendulum had a separate strain gauge, the data for the aluminum trials is not suspect. The experimentally acquired LabView data can be found in Appendix X, Table 1.

The 90% confident mean population values were found using the “Student T-Distribution Method” described at the end of the Aerolab Structures Lab Manual. For each length and material, the number of sample points (v) was four. α was found using the equation:

From these values, Table A.4 in the Aerolab Structures Lab Manual was used to find the value of tα/2 = 1.533. These values can be found in Appendix X, Table 2 for reference. The equation:

Was used to calculate the range of 90% confident mean population values for the frequencies. The results of this calculation can be found in Appendix X, Table 3.

The time history file for each data run was transferred into excel and used to recreate the Strain vs. Time plots produced by LabView during the experiment. However, since each run has 6,000 data points, these charts are not included in this report, though they can be made available if requested. The data plots for each material, length, and trial can be found in Appendix X, Figures 1-12.

A moment of inertia about the shaft axis was calculated for both materials using readily available material property values and pendulum dimensions recorded during the experiment. These values can be found in Appendix X, Tables 4 and 5. The formula:

Was used to calculate the moment of inertia, where *W* is the weight of the disk, *D* is the dis diameter, and *G* is the shear modulus of the shaft material. *W* was calculated using the disk’s dimensions and the equation:

Where *t* is the disk thickness and ρ is the disk density. The rotational spring constant was calculated using the equation:

Where *d* is the shaft diameter and *l* is the shaft length. The rotational spring constant was then used to calculate the natural frequency, ω, and the frequency, *f* using the equations:

The results of these calculations can be found in Appendix X, Table 5. The natural frequencies for the theoretical and experimental Aluminum lengths appear to be very similar, though the values for steel appear to be significantly different.

In order to find the logarithmic decrement, it was necessary to find *umi* , *um(i+1)* , and *j*. The lab manual recommended using the starting and ending amplitudes for *umi* , *um(i+1)*  and the number of cycles between 90° > φ > 45°. However, this range of times was not recorded during the experiment. Instead, the starting amplitude, ending amplitude, and total number of cycles for the 60 second observation period were used. The logarithmic decrement was calculated using the equation:

The damping ratio, ζ, was calculated using the equation:

The results of this calculation can be found in Appendix X, Table 5. The theoretical damping ratios were all greater than the corresponding observed values (Appendix X, Table 1) by a significant margin.

The damping ratio was then used to calculate the damped frequency using the equation:

The results of this calculation can be found in Appendix X, Table 5. Similar to the results of the natural frequency calculations, the damped frequencies for both aluminum lengths appear to match closely to the experimental values, with a percent difference of 0.795% for the first length and 0.712% for the second. However, the experimental and theoretical values for the steel data contrast sharply, with a percent difference greater than 19%. These percent differences can be found in Appendix X, Table 6, for reference.